



(12) **United States Patent**
Feng et al.

(10) **Patent No.:** **US 9,054,811 B2**
(45) **Date of Patent:** **Jun. 9, 2015**

(54) **METHOD AND DEVICE FOR SENDING UPSTREAM TRANSFER FRAME IN PASSIVE OPTICAL NETWORK**

(58) **Field of Classification Search**
None
See application file for complete search history.

(75) Inventors: **Dongning Feng**, Shenzhen (CN); **Dongyu Geng**, Shenzhen (CN); **Jing Li**, Shenzhen (CN); **Wai Kong Raymond Leung**, Shenzhen (CN); **Frank Effenberger**, Bridgewater, NJ (US)

(56) **References Cited**
U.S. PATENT DOCUMENTS

7,307,551 B2 12/2007 Inoue et al.
7,991,296 B1 * 8/2011 Johnston et al. 398/154
8,199,775 B2 * 6/2012 Mori 370/474

(Continued)

(73) Assignee: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (CN)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 390 days.

CN 101364844 A 2/2009
EP 2299609 A1 3/2011

(Continued)

(21) Appl. No.: **13/565,471**

OTHER PUBLICATIONS

(22) Filed: **Aug. 2, 2012**

Office Action issued in corresponding Chinese Patent Application No. 200980155639.4, mailed Jul. 1, 2013, 10 pages.

(65) **Prior Publication Data**

(Continued)

US 2014/0233948 A1 Aug. 21, 2014

Related U.S. Application Data

Primary Examiner — Phirin Sam

(74) *Attorney, Agent, or Firm* — Brinks Gilson & Lione

(63) Continuation of application No. 13/219,075, filed on Aug. 26, 2011, now Pat. No. 8,259,734, which is a continuation of application No. PCT/CN2009/074496, filed on Oct. 19, 2009.

(57) **ABSTRACT**

The present invention relates to the Passive Optical Network (PON) technology, and a method for sending an upstream transfer frame in a PON is provided. The method includes: after success of link, sending a preamble according to an allocated time slot, sending a burst synchronization delimiter, and then sending successively a burst header, a Gigabit-Capable Passive Optical Network (GPON) Transmission Convergence (GTC) frame header, and GTC frame data. In the sent synchronization delimiter, the number of zeros on the odd bits is N, the number of non-zeros on the odd bits is M, a relation $|N-M| \leq 1$ is satisfied, the max number of zeros in a continuous zero group is X, the max number of non-zeros in a continuous nonzero group is Y, and a relation $|X-Y| \leq 1$ is satisfied. A device for sending an upstream transfer frame in a passive optical network is further provided.

(30) **Foreign Application Priority Data**

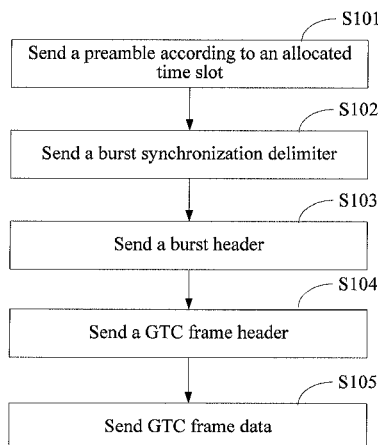
Feb. 27, 2009 (WO) PCT/CN2009/070585

(51) **Int. Cl.**
H04L 12/28 (2006.01)
H04B 10/27 (2013.01)

(Continued)

(52) **U.S. Cl.**
CPC **H04B 10/27** (2013.01); **H04L 7/041** (2013.01); **H04L 7/046** (2013.01); **H04Q 11/0067** (2013.01)

10 Claims, 2 Drawing Sheets



- (51) **Int. Cl.**
H04L 7/04 (2006.01)
H04Q 11/00 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,259,734	B2 *	9/2012	Feng et al.	370/395.51
2002/0003812	A1	1/2002	Haartsen	
2002/0120758	A1	8/2002	Chang	
2002/0171895	A1	11/2002	Chang	
2004/0258094	A1 *	12/2004	Bashan et al.	370/486
2005/0254491	A1	11/2005	Lenell et al.	
2008/0002973	A1	1/2008	Yamabana et al.	
2008/0050116	A1 *	2/2008	Nakaishi et al.	398/43
2008/0069562	A1	3/2008	Ivry	
2009/0123159	A1	5/2009	Leung et al.	
2009/0180491	A1	7/2009	Sala et al.	
2009/0226170	A1	9/2009	Zou	
2010/0080558	A1 *	4/2010	Kazawa et al.	398/66
2010/0111532	A1	5/2010	Chen et al.	
2010/0208752	A1	8/2010	Julien et al.	
2010/0322626	A1	12/2010	Kim et al.	
2011/0200326	A1	8/2011	Kazawa et al.	
2011/0200328	A1	8/2011	In De Betou et al.	
2011/0211827	A1	9/2011	Soto et al.	
2014/0023367	A1 *	1/2014	Li et al.	398/58

FOREIGN PATENT DOCUMENTS

JP	2004266524	A	9/2004
WO	2009/152668	A1	12/2009

OTHER PUBLICATIONS

Takigawa et al., "ATM based Passive Double Star system offering" IEEE 1993, 5 pages.
 Opinion of the International Search Report issued in corresponding PCT Patent Application No. PCT/CN2009/070585, mailed Dec. 3, 2009.

Written Opinion of the International Searching Authority issued in corresponding PCT Patent Application No. PCT/CN2009/070585, mailed Dec. 3, 2009.

Written Opinion of the International Searching Authority issued in corresponding PCT Patent Application No. PCT/CN2009/074496, mailed Jan. 28, 2010.

Opinion of the International Search Report issued in corresponding PCT Patent Application No. PCT/CN2009/074496, mailed Jan. 28, 2010.

Office Action issued in commonly owned U.S. Appl. No. 13/270,035, mailed Dec. 5, 2011.

Extended European Search Report issued in corresponding European Patent Application No. 09840652.3, mailed Jun. 12, 2012.

Takigawa et al., "ATM based Passive Double Star System Offering" IEEE 1993.

International Telecommunication Union, "Gigabit-capable Passive Optical Networks(GPON): Physical Media Dependent (PMD) Layer Specification" Series G: Transmission Systems and Media, Digital Systems and Networks, Digital Sections and Digital Line System—Optical Line Systems for Local and Access Networks. G.984.2, Mar. 2003.

Effenberger et al., "FEC Synchronization and Framing" P802.3av. Monterey, California, Jan. 15, 2007.

Office Action issued in commonly owned U.S. Appl. No. 13/219,075, mailed Dec. 1, 2011.

Office Action issued in corresponding European Patent Application No. 09840652.3, mailed Mar. 13, 2013.

Notice of Allowance issued in commonly owned U.S. Appl. No. 13/270,035, mailed May 2, 2012.

Notice of Allowance issued in commonly owned U.S. Appl. No. 13/270,035, mailed Aug. 2, 2012.

Notice of Allowance issued in commonly owned U.S. Appl. No. 13/219,075, mailed May 4, 2012.

ITU, "Draft of G.984.3 Revised" Telecommunication Standardization Sector, Study Group 15, Study Period 2005-2008.

Baohua et al., "Study on Bandwidth Utilization Ratio of GPON Systems" Study on Optical Communications, Sum. No. 139, 2007.

* cited by examiner

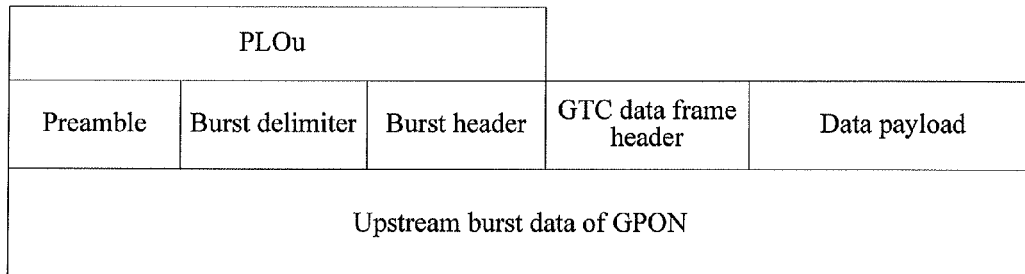


FIG. 1

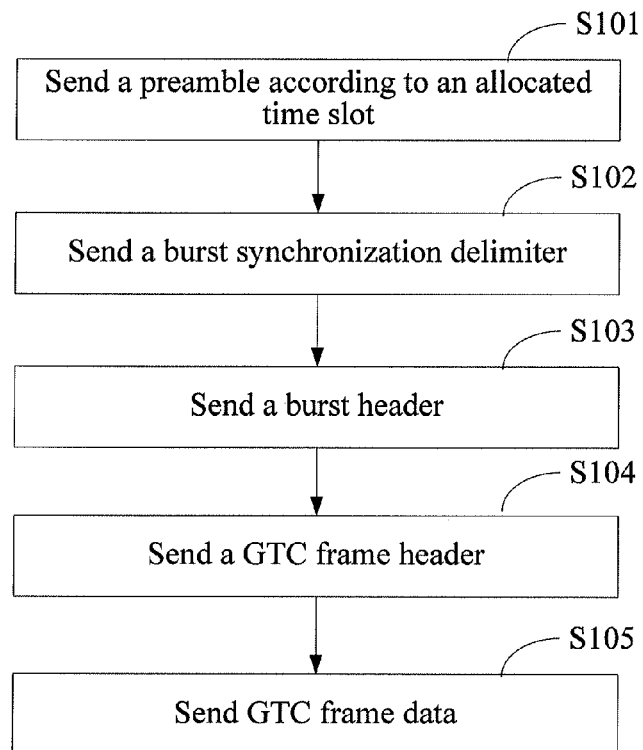


FIG. 2

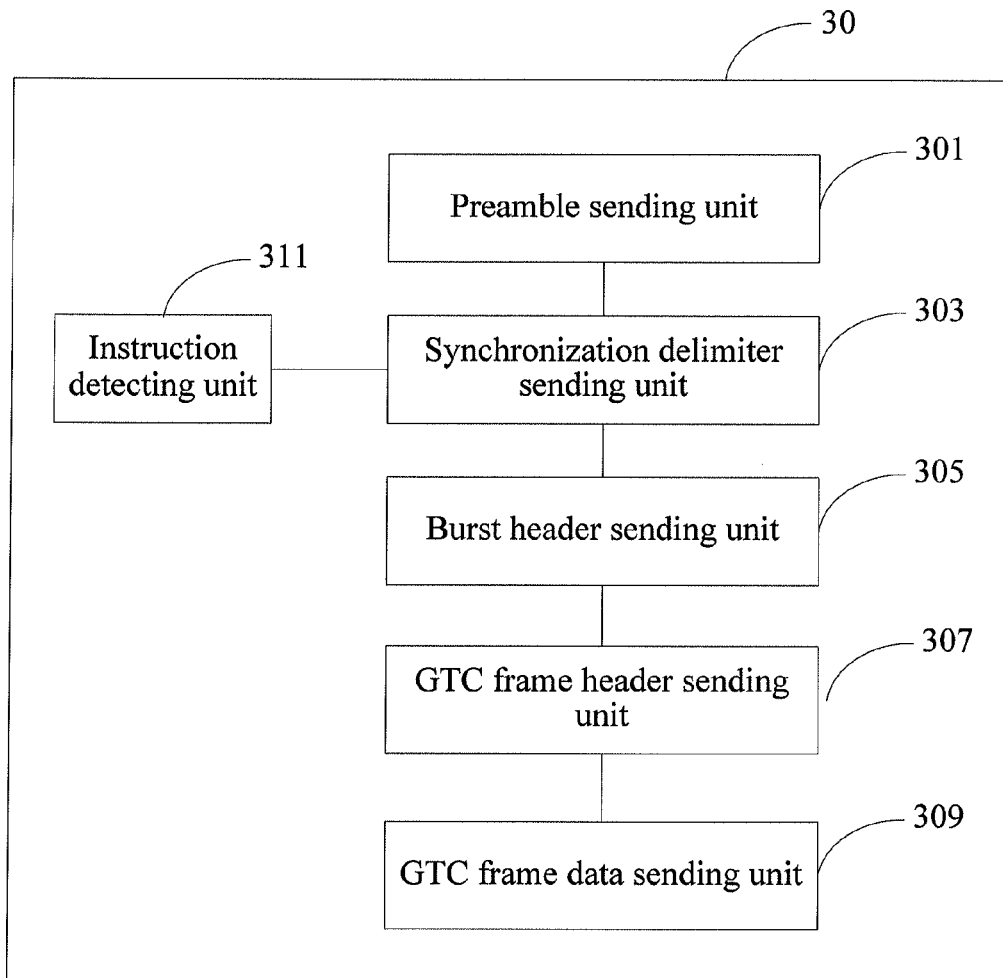


FIG. 3

1

METHOD AND DEVICE FOR SENDING UPSTREAM TRANSFER FRAME IN PASSIVE OPTICAL NETWORK

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/219,075, filed on Aug. 26, 2011, which is a continuation of International Application No. PCT/CN2009/074496, filed on Oct. 19, 2009. The International Application claims priority to International Application No. PCT/CN2009/070585, filed on Feb. 27, 2009 both of which are hereby incorporated by reference in their entireties.

FIELD OF THE INVENTION

The present invention relates to a Passive Optical Network (PON) technology, and in particular, to a method and device for sending an upstream transfer frame in a PON.

BACKGROUND OF THE INVENTION

Due to advantages of easy maintenance, high bandwidth, and low cost, the PON, as an ideal physical platform in which various services, such as voice, data, and video, are accessed in an integrated manner through a single platform, becomes the best in optical access technologies. The PON technology is a Point to Multipoint (P2MP) optical fiber access technology. The PON is formed by an Optical Line Terminal (OLT), Optical Network Units (ONUs), and an Optical Distribution Network (ODN), and the advantages come from a passive optical splitter/coupler in the ODN, so that the PON does not need to use elements that have amplifying and relaying functions. The PON adopts a P2MP topology structure, so that the PON needs to adopt a P2MP multiple access protocol to enable the ONUs to share the OLT and the backbone optical fiber. It is agreed in the PON system that a direction of data from the OLT to the ONU is a downstream direction, and a direction from the ONU to the OLT is an upstream direction. Currently, in terms of the borne content, the PON may be divided into many types, where Gigabit-Capable Passive Optical Network (GPON) is relatively important. The GPON system adopts a Wavelength Division Multiplexing (WDM) technology, and realizes bi-directional transmission in a single fiber. In order to separate signals in come and go directions of a plurality of users on the same optical fiber, a downstream data stream adopts a broadcast technology; and an upstream data stream adopts a Time Division Multiple Access (TDMA) technology.

Transmission of the GPON in the upstream direction is in a burst mode. Each ONU sends data to the OLT according to a particular time slot allocated by the OLT. When receiving the data of each ONU, the OLT needs to first perform synchronization to acquire a start position of a data frame sent by the ONU, and then start to receive the data. In ITU-T G.984.3 standard, an upstream burst receiving synchronization mechanism is given. A preamble field and a delimiter field are set in the front of an upstream burst frame of the GPON. The OLT performs receiving synchronization of the upstream burst frame by using the two fields.

The preamble field is a string of binary sequence, which is convenient for a receiving end of the OLT to perform automatic gain control, clock recovery, and synchronous receiving. When receiving the upstream burst frame, the OLT enables the delimiter to match the received upstream burst frame. After success of matching, the OLT may learn the start

2

position of the data in the burst frame, so as to finish the synchronization operation. In the solution of the prior art, six types of delimiter fields are defined, and the user may select one to perform configuration as required.

The error probability defined in the current GPON system is 10^{-4} , and $P(\text{lost_burst}) \leq 10^{-10}$. The delimiter given in the G984.3 standard can only satisfy the requirement of the existing GPON system. However, in the GPON system of the next generation, both upstream and downstream transmission rates need to be improved and are required to support full service, so that new requirements are brought to the bit error rate of the channels and the receiving end. It is quite difficult for the delimiter field that has the length of 16 bits or 20 bit and is given in the prior art to satisfy the requirement of the GPON system of the next generation, so that it is necessary to provide a new burst synchronization delimiter field and a method for sending an upstream transfer frame.

SUMMARY OF THE INVENTION

An embodiment of the present invention provides a method for sending an upstream transfer frame in a PON, so as to improve flexibility of a system and reduce an error probability.

The method includes:

after success of link, sending a preamble according to an allocated time slot;

sending a burst synchronization delimiter, where in the sent synchronization delimiter, the number of non-zeros is the same as the number of zeros, and in a delimiter sequence, the number of non-zeros on odd bits is equal to the number of zeros on even bits, and the number of non-zeros on even bits is equal to the number of zeros on odd bits, the number of zeros on the odd bits is N, the number of non-zeros on the odd bits is M, a relation $|N-M| \leq 1$ is satisfied, in the burst synchronization delimiter, the number of zeros in a continuous zero group is X, the number of non-zeros in a continuous non-zero group is Y, a relation $|X-Y| \leq 1$ is satisfied; and sending in sequence a burst header, a GPON Transmission Convergence (GTC) frame header, and GTC frame data.

An embodiment of the present invention further provides a device for sending an upstream transfer frame in a PON, which includes: an preamble sending unit, configured to send a preamble according to an allocated time slot;

a synchronization delimiter sending unit, configured to send a burst synchronization delimiter, where in the sent synchronization delimiter, the number of non-zeros is the same as the number of zeros, and in a delimiter sequence, the number of non-zeros on odd bits is equal to the number of zeros on even bits, and the number of non-zeros on even bits is equal to the number of zeros on odd bits, the number of zeros on the odd bits is N, the number of non-zeros on the odd bits is M, a relation $|N-M| \leq 1$ is satisfied, that is, a difference between N and M is not greater than 1; in the synchronization delimiter, the number of zeros in a continuous zero group is X, the number of non-zeros in a continuous non-zero group is Y, and a relation $|X-Y| \leq 1$ is satisfied; and

a burst header sending unit, configured to send a burst header;

a GTC frame header sending unit, configured to send a GTC frame header; and

a GTC frame data sending unit, configured to send GTC frame data.

In the embodiments of the present invention, a method that is capable of sending an upstream transfer frame of a GPON system of the next generation is provided, where a better delimiter sequence is adopted, and a sequence provided in the

embodiments of the present invention may effectively improve the flexibility of the system and reduce the error probability.

BRIEF DESCRIPTION OF THE DRAWINGS

To illustrate the technical solutions according to the embodiments of the present invention or in the prior art more clearly, the accompanying drawings for describing the embodiments or the prior art are introduced briefly in the following. Apparently, the accompanying drawings described in the following are only some embodiments of the present invention, and persons of ordinary skill in the art can derive other drawings from the accompanying drawings without creative efforts.

FIG. 1 is a schematic structure diagram of an upstream burst frame of a GPON according to an embodiment of the present invention;

FIG. 2 is a flow chart of a method for sending an upstream transfer frame in a PON according to an embodiment of the present invention; and

FIG. 3 is a structure block diagram of a device for sending an upstream transfer frame in a PON according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The technical solutions of the present invention will be clearly and completely described in the following with reference to the accompanying drawings. It is obvious that the embodiments to be described are only a part rather than all of the embodiments of the present invention. All other embodiments obtained by persons skilled in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

In upstream transmission of a PON system, data is transferred in a time division multiplex access manner. An upstream link is divided into different time slots, and an upstream time slot is allocated to each ONU according to an upstream bandwidth map information field of a downstream frame, so that all of the ONUs may send the data according to a certain order, thereby eliminating conflicts due to the contest on the time slots.

In the embodiment of the present invention, the illustration is given in combination with a GPON system, a structure of an upstream burst frame of the GPON is as shown in FIG. 1. The upstream burst frame of the GPON is formed by a Physical Layer Overhead upstream (PLOu) field, a GTC overhead (data frame header) field, and a GTC payload (data payload) field. Guard Time is protection time between burst frames, and is added to a frame header of the burst frame.

The PLOu is a physical control header of a burst frame of the GPON, and is mainly used for frame positioning, synchronization, and identifying the ONU that sends the frame. The PLOu is formed by a Preamble (preamble), a Delimiter (burst synchronization delimiter), and a Burst Header (burst header). The GTC Overhead is a data frame header of a GTC framing sub-layer data packet, and includes a Physical Layer Operation Administration Maintenance upstream (PLOAMu) and a Dynamic Bandwidth Report upstream (DBRu). The PLOAMu mainly reports a Physical Layer Operation Administration Maintenance (PLOAM) message of the upstream data, which is mainly an administration message of maintenance and administration states of the ONU. The DBRu is mainly used to apply for a bandwidth for the next transmission, so as to finish Dynamic Bandwidth

Assignment (DBA) of the ONU. During application, possibly not every frame includes the PLOAMu and the DBRu, and the OLT and the ONU need to negotiate about the issue that which frame can include the PLOAMu and the DBRu. The GTC payload is data payload, and may be a DBA state report or a data frame. If the GTC payload is the data frame, the GTC payload may be divided into a GPON Encapsulation Method (GEM) header and a GEM Frame.

FIG. 2 is a flow chart of a method for sending an upstream transfer frame applied in a PON.

S101: Send a preamble according to an allocated time slot; during specific implementation, the preamble is preferentially selected as a sequence binarily represented as 1010 1010 . . . (hexadecimally represented as 0x AA . . .).

S102: Send a burst synchronization delimiter, where in the sent synchronization delimiter, the number of non-zeros is the same as the number of zeros, and in a delimiter sequence, the number of non-zeros on odd bits is equal to the number of zeros on even bits, and the number of non-zeros on even bits is equal to the number of zeros on odd bits; the number of zeros on the odd bits is N, the number of non-zeros on the odd bits is M, a relation $|N-M| \leq 1$ is satisfied, that is, a difference between N and M is not greater than 1 (or the number of zeros on the even bits is N, and the number of non-zeros is M, the relation $|N-M| \leq 1$ is satisfied); in the synchronization delimiter, the number of zeros in a continuous zero group is X, the number of non-zeros in a continuous non-zero group is Y, and a relation $|X-Y| \leq 1$ is satisfied.

S103: Send a burst header, configured to detect a link bit error rate, an identifier ONU-ID, and a real-time state report of the ONU.

S104: Send a GTC frame header.

S105: Send GTC frame data.

During specific implementation, system differentiation may be added, when it is necessary to select the transmission rate, the upstream transmission rate is determined, and delimiter instructions A and B corresponding to two rates are defined in the PLOAM downstream (PLOAMd), where A is 2.5 gigabits per second (Gbps) and B is 10 Gbps. The rates should be determined before step S102. Before the burst synchronization delimiter is sent, the upstream transmission rate is determined.

The preamble, the delimiter, and the pre-time delay of the physical control header of the ONU upstream burst frame of the GPON system are set according to parameters in Upstream_Overhead sent by the OLT. The delimiter of the ONU upstream burst frame is used to enable a receiving end of the OLT to correctly synchronize with the upstream burst frame sent by the ONU. The incorrect burst frame synchronization may result in the prolonging of the time delay of the system, or even result in the breakdown of the receiving end of the OLT, so that the selected delimiter needs to reduce the probability of the incorrect synchronization as much as possible. Forward Error Control (FEC) encoding is not performed on the delimiter, that is, the delimiter is not protected by the FEC. Therefore, the self-relativity of the delimiter is required to be large, and a relativity value of the delimiter with a shift sequence is required to be as small as possible, that is, the shift sequence's minimum hamming distance between the delimiter and the sequence formed by the preamble and the delimiter is required to be as large as possible.

The delimiter is not protected by the FEC encoding, during a channel transmission procedure, due to interference of noise, the bit error rate is relatively high. Therefore, it is required that under a condition that synchronization performances are not affected, the receiving end of the OLT shall set an acceptable bit error rate to improve the synchronization

5

probability of the burst frame synchronization or reduce the time delay resulting from the synchronization. The acceptable bit error rate is a bit error threshold, for example,

$$\left\lfloor \frac{L}{4} - 1 \right\rfloor,$$

where L is the length of the burst synchronization delimiter.

The embodiment of the present invention provides a group of delimiter sequences applicable to the GPON system of the next generation, where if the delimiter sequence is Direct Current (DC) Balance, that is, the number of non-zeros is the same as the number of zeros, and in the delimiter sequence, the number of non-zeros on the odd bits is equal to the number of zeros on the even bits, and the number of non-zeros on the even bits is equal to the number of zeros on the odd bits; the number of zeros on the odd bits is N, the number of non-zeros on the odd bits is M, the relation $|N-M| \leq 1$ is satisfied, that is, the difference between N and M is not greater than 1; the number of zeros in a continuous zero group is X, the number of non-zeros in a continuous non-zero group is Y, and the relation $|X-Y| \leq 1$ is satisfied.

The delimiter sequences matching the preamble being 1010 1010 . . . (formed by a cycle of 10) are as shown in Table 1, that is, the minimum hamming distance between the delimiter and the shift sequence of the delimiter is

$$\left\lfloor \frac{L-1}{2} \right\rfloor$$

(where L is the length of the burst synchronization delimiter), so that under the condition that the corresponding complexity is not increased in the system, the incorrect synchronization lock probability of the burst synchronization between the receiving end of the OLT and the upstream burst frame sent by the ONU is effectively reduced.

6

The OLT selects the corresponding delimiter sequence from the Table 1 according to requirements of different systems. For example, for the GPON system of the next generation, the sequence (binarily represented as 10100101011001100111100111100000) that has the length of 32 bits and is defined as 0x A56679E0 may be selected.

In a specific implementation manner, a sending end of the OLT defines the sequence in Upstream_Overhead, and then the OLT embeds the defined Upstream_Overhead into the downstream PLOAMd instruction. The ONU sets the synchronization delimiter of the upstream burst frame according to the delimiter in Upstream_Overhead in the received PLOAMd.

In the embodiment of the present invention, another method for generating the delimiter is given. In the PON system, for ease of synchronization and clock recovery, a line encoding technology is adopted. In the upstream transmission, nBmB encoding may be adopted. The principle of the nBmB encoding is that after being encoded, data of n bits forms a code word of m bits, and a code stream after the encoding satisfies the requirement of DC balance, and the requirement that the number of continuous 0 and the number of continuous 1 are as small as possible. The nBmB encoding is generally divided into data and control. For the data, the data of n bits is corresponding to the code word of m bits. For the upstream burst frame, the GTC adopts the nBmB encoding, in order to make the delimiter have better characteristics, the delimiter may be formed by one or more code words in the nBmB encoding.

If the PON system adopts a 9B10B line encoding mechanism, the delimiter according to the embodiment of the present invention may be generated according to the 9B10B encoding method. Table 2 provides a group of delimiters corresponding to the illustration of the embodiment of the present invention, where the group of delimiters is formed by code words encoded by 9B10B.

TABLE 1

Delimiter sequences provided in the embodiment of the present invention		
Bit length	Delimiter sequence (binary)	Delimiter sequence (hexadecimal)
24	111110000101001010011001 100000111101011010011001	F85299 83D699
28	1011011101101001000011110000 0011101111010100001011001001	B769F0 3BD42C9
30	101111011101100000110100100001 00100000110110011110100101011	2F760D21 08367A57
32	1001101101010010111110001100000 10100101011001100111100111100000 10111001010011111001011000000110 10101101010011001100001100001111	9B52FC60 A56679E0 B769F0 AD4CC30F
36	10100101111011010000111000011001100 10100000010111100110011100101101001	A5F6870CC A05F33969
40	1111101010010101011000011010010011001100 101111101100100011000111000000101101001	FA9561A4CC BF64638169
44	1010000111000001000011011110110110100011011 11101110011001010000010010111001011000001111 10101101010010000001011001111110001100111100	A1C10DEED1B EE6504B960F AD48167E33C
48	10101101111010100101001000001101110010011000011 10100101010010011111001001111011100110000001100	ADF52906E4C3 A549F27BCC0C ii
64	111010100101000000010010001111001101000111111011000 1100110100111 110011101001100111001110010111100101000000101000101 1010000011111 111000111001110100011001000010100000011111011000100 1011011011011 101100111011110111010011000100001011001011000101000 0111110100001	EA50123CD1FB19A7 CE99CE5E5028B41F E39D190A07D896DB B3BDD310B2C50FA1

TABLE 2

Delimiter sequences provided in the embodiment of the present invention		
Bit length	Delimiter sequence (binary)	Delimiter sequence (hexadecimal)
30	110011000110010010001101001111	3319234F
40	1000001001011111000111101010010111001100	825F1EA5CC
	10100001011100001001001100011110111101	A170931EF6
	10111111000101101100111000000100011010	BF16CE0469
	10001111010011110110100001000110100110	8F4F684699
	10111111000001010010001001001111001110	BF05224F39

The delimiter sequence of 30 bits provided in Table 2 is formed by 3 code words of 10 bits encoded by 9B10B, where

ing, so that in addition to the existing method of adding the delimiter sequence, a 9B sequence corresponding to 10B sequence may be added to the sending end, and then the delimiter is generated by the 9B10B encoding of the sending end of the ONU.

Table 1 and Table 2 of the delimiter sequences provided in Embodiment 1 of the present invention are based on the preamble 1010 1010 . . . (formed by the cycle of 10) sequence; if the preamble sequence is changed to a 0101 0101 . . . (formed by the cycle of 01) sequence, and a sequence acquired by performing negation on the binary sequence provided in the embodiment also satisfies the characteristics of the burst synchronization delimiter of the present invention. For example, after the negation is performed on 111110000101001010011001, 000001111010110101100110 is acquired.

If the preamble sequence is formed by connecting a plurality of 1011011010100100001111000100110 sequences (hexadecimally represented as 0x BB521E26) from end to end, Table 3 provides burst synchronization delimiter sequences satisfying this embodiment.

TABLE 3

Delimiter sequences provided in the embodiment of the present invention		
Bit length	Delimiter sequence (binary)	Delimiter sequence (hexadecimal)
32	01111100011101100101000100001011 00001011011110000111011101010001 01111001011101100101000100001011 01001011110111100001101110010000 10100011011101100111000011001001	7C76510B 0B787751 7976510B 4BDE1B90 A37670C9
64	101110011101010000111110011010000100011000101 0111100000110010111 101110110101000010011110011001100100010010101 1110110000111001001 111110100011001000011110001000010000010111001 1011110100111010110 101110110101001000011110001000100100010010101 1011011000111011101 101101110101001000011111000001100100100010101 1011110100001111001 101010111101001000011110001001100101010100101 1011110000110011001	B9D43E68462BC197 BB509E6644AF61C9 FA321E2105CDE9D6 BB521E2244ADB1DD B7521F0648ADE879 ABD21E26552DE199

the relativity between the 3 characters of 10 bits and the code words generated by 9B10B encoding is small, and it is easy to differentiate them. Similarly, the delimiter of 40 bits provided in Table 2 is formed by 4 code words of 10 bits. The delimiter sequence provided by Table 2 is generated by 9B10B encod

If the preamble sequence is formed by a plurality of 11101101010010000111100010011010 sequences (hexadecimally represented as 0x ED48789A) from end to end, Table 4 provides burst synchronization delimiter sequences satisfying this embodiment.

TABLE 4

Delimiter sequences provided in the embodiment of the present invention		
Bit length	Delimiter sequence (binary)	Delimiter sequence (hexadecimal)
32	10110111110001110110010100010000 11001010001001010110111100001110 01100101000100011011011110000111 0111010100010000101101111000110 11011011110000110011001010001001 11101100101000110001011011110000 10110000110010001101111000011101 110010100010010110011100001111	B7C76510 CA256F0E 6511B787 7510B7C6 DBC33289 ECA316F0 B0C8DE1D CA25670F

TABLE 4-continued

Delimiter sequences provided in the embodiment of the present invention		
Bit length	Delimiter sequence (binary)	Delimiter sequence (hexadecimal)
64	11111001110001100010011011010000	F9C626D0
	11001111000011011100001000100110	CF1DC226
	111011010100010000111100010011110011001010110	ED48789F32B78524
	1111000010100100100	
	011011010111111000101000110011101001001010000	6D7E28CE9281D539
	0011101010100111001	
	111010010100000001111001000110110001011010111	E940791B16BF86CC
	1111000011011001100	
	111011000100000100111000001110100001001110111	EC41383A13BED6C5
	1101101011011000101	

Further, different delimiter sequences may be used to differentiate whether a certain application function is started, for example, FEC encoding.

Before the burst synchronization delimiter is sent, an application function selecting instruction is detected, and the preset burst synchronization delimiter is selected according to the application function selecting instruction.

For example, the OLT may define in the PLOAMd two delimiter instructions C and D for differentiating whether a function is started, where C indicates that a certain function is carried, and D indicates that the function does not exist or the function is not started. For example, if the ONU detects the C instruction, the ONU adds the delimiter sequence: 0x AD4CC30F (binarily represented as 101011010100110001100001100001111) that has the length of 32 bits and is provided by the present invention, which indicates that the OLT and the ONU have the FEC function; if the ONU detects the D instruction, the ONU adds the delimiter sequence: 0x A56679E0 (binarily represented as 10100101011001100111100111100000) having the length of 32 bits and provided by the present invention, and the delimiter sequence indicates that the OLT and the ONU do not have the FEC function, or the FEC function does not need to be started.

It may be known from the foregoing illustration that a corresponding relation between the preset burst synchronization delimiter and the function application instruction may be preset.

Alternatively, in order to improve the accuracy of detecting the upstream burst frame by the receiving end, the OLT may select two groups of sequences with the length of 64 bits as the two delimiter instructions C and D. When the ONU detects the C instruction, for example, the FEC function exists, the ONU adds the delimiter sequence: 0x E39D190A 07D896DB (binarily represented as 111000111001110100011001000010100000011110110-001001011011011011) that has the length of 64 bits and is provided by the present invention, which indicates that the FEC encoding is performed on the upstream burst frame sent by the ONU; if the ONU detects the D instruction, for example, the FEC function does not exist, or the FEC function does not need to be started, the ONU adds the delimiter sequence: 0x B3BDD310 B2C50FA1 (binarily represented as 101100111011101110100110001000010110010-11000101000011110100001) that has the length of 64 bits and is provided by the present invention, and the delimiter sequence indicates that the FEC encoding is not performed on the upstream burst frame sent by the ONU, or the FEC function does not need to be started.

Alternatively, the OLT directly sends the sequence that is used to indicate whether a certain application function (for example, the FEC function) exists to the ONU, and the ONU uses the received sequence as the burst synchronization delimiter of the upstream burst frame. For example, the burst synchronization delimiter being 0x E39D190A 07D896DB (binarily represented as 111000111001110100-011001000010100000011110110001001011011011) indicates that the FEC encoding needs to be performed on the upstream burst frame sent by the ONU; and the burst synchronization delimiter being 0x B3BDD310 B2C50FA1 (binarily represented as 1011001110111011-1010011000100001011001011000101000011110100001) indicates that the FEC encoding does not need to be performed on the upstream burst frame sent by the ONU, or the FEC function does not need to be started.

Alternatively, each ONU presets the delimiter sequence of the upstream burst frame, and the OLT detects the burst synchronization delimiter sequence in the received upstream burst frame to determine whether it is necessary to perform a certain function operation on the frame, for example, FEC decoding. For example, the burst synchronization delimiter being 0x E39D190A 07D896DB (binarily represented as 11100011100111010001100100001010000001111011-0001001011011011011) indicates that the FEC decoding needs to be performed on the upstream burst frame sent by the ONU; and the burst synchronization delimiter being 0x B3BDD310 B2C50FA1 (binarily represented as 10110011101110111010011000100001011001011000-101000011110100001) indicates that the FEC decoding does not need to be performed on the upstream burst frame sent by the ONU, or the FEC function does not need to be started.

Further, the OLT may request the ONU to transfer different delimiter sequences according to a line encoding mechanism of the ONU end.

Therefore, before the burst synchronization delimiter is sent, a line encoding mechanism instruction is detected, and the preset burst synchronization delimiter is selected according to the line encoding mechanism instruction.

For example, the GPON system of the next generation may support at least one of 9B 10B encoding and Non Return to Zero (NRZ) modulation. For example, the OLT may define in the PLOAMd delimiter instructions E and F corresponding to the two mechanisms, where E is corresponding to the 9B10B encoding mechanism and F is corresponding to the NRZ modulation mechanism. After detecting the corresponding instruction, the ONU adds the delimiter, if the ONU detects the E instruction, the ONU adds the delimiter sequence: 0x BF05224F39 (binarily represented as

11

1011111100000101001000100100111100111001) that has the length of 40 bits and is provided by the present invention; if the ONU detects the F instruction, the ONU adds the delimiter sequence: 0x A56679E0 (binarily represented as 10100101011001100111100111100000) that has the length of 32 bits and is provided by the present invention. Alternatively, the ONU may add the delimiter sequence defined in the PLOAMd instruction sent by the OLT to the upstream burst frame, where the OLT sends the corresponding delimiter sequence according to the encoding mechanism of the ONU; if it is detected that the 9B 10B encoding is performed at the ONU end, the delimiter sequence: 0x BF05224F39 (binarily represented as 1011111100000101001000100100111100111001) that has the length of 40 bits and is provided by the present invention is added; if it is detected that the NRZ modulation is performed at the ONU end, the delimiter sequence: 0x A56679E0 (binarily represented as 10100101011001100111100111100000) that has the length of 32 bits and is provided by the present invention is added.

In the embodiment of the present invention, the method capable of sending the upstream transfer frame of the GPON system of the next generation is provided, where a better delimiter sequence is adopted, and the sequence provided in the embodiment of the present invention may effectively improve the flexibility of the system.

Meanwhile, an embodiment of the present invention provides a device for sending an upstream transfer frame in a PON, and during application, the device may be used as an ONU. FIG. 3 is a structure block diagram of a device 30 for sending the upstream transfer frame in the PON. In this embodiment, the device 30 for sending the upstream transfer frame in the PON includes a preamble sending unit 301, a synchronization delimiter sending unit 303, a burst header sending unit 305, a GTC frame header sending unit 307, and a GTC frame data sending unit 309.

The preamble sending unit 301 sends a preamble according to an allocated time slot. During specific implementation, the preamble is preferentially selected as a sequence (hexadecimally represented as 0x AA . . .) binarily represented as 1010 1010 . . . (formed by a cycle of 10).

After finishing sending the preamble, the synchronization delimiter sending unit 303 sends a burst synchronization delimiter, where in the sent synchronization delimiter, the number of non-zeros is the same as the number of zeros, and in a delimiter sequence, the number of non-zeros on odd bits is equal to the number of zeros on even bits, and the number of non-zeros on even bits is equal to the number of zeros on odd bits; the number of zeros on the odd bits is N, the number of non-zeros on the odd bits is M, a relation $|N-M| \leq 1$ is satisfied, that is, a difference between N and M is not greater than 1; in the synchronization delimiter, the number of zeros in a continuous zero group is X, and the number of non-zeros in a continuous non-zero group is Y, a relation $|X-Y| \leq 1$ is satisfied.

The burst header sending unit 305 is configured to send a burst header.

The GTC frame header sending unit 307 is configured to send a GTC frame header.

The GTC frame data sending unit 309 is configured to send GTC frame data.

The device further includes an instruction detecting unit 311, configured to detect instruction information in a downstream broadcast frame sent by an OLT, where the synchronization delimiter sending unit 303 selects the preset synchronization delimiter according to the instruction information and sends the preset synchronization delimiter. The instruc-

12

tion information herein may be an application function, an application function selecting instruction, or upstream transmission rate information, and during application, the instruction information may carry 2 or 3 of the foregoing information.

When the preamble is a 1010 1010 . . . sequence, the burst synchronization delimiter sent by the synchronization delimiter sending unit 303 is hexadecimally represented as: A56679E0, the burst synchronization delimiter is binarily represented as: 10100101011001100111100111100000.

Alternatively, the burst synchronization delimiter is hexadecimally represented as: BF05224F39, and the burst synchronization delimiter is binarily represented as: 1011111100000101001000100100111100111001.

When the preamble is a 1010 1010 . . . sequence, the burst synchronization delimiter sent by the synchronization delimiter sending unit 303 is one of hexadecimal sequences in the following:

F85299, 83D699, B7690F0, 3BD42C9, 2F760D21, 08367A57, 9B52FC60, B94F9606, AD4CC30F, A5F6870CC, A05F33969, FA9561A4CC, BF164638169, A1C10DEED1B, EE6504B960F, AD48167E33C, ADF52906E4C3, A549F2BCC0C, 3319 234F, 82 5F1E A5CC, A1 7093 1EF6, BF 16CE 0469, 8F 4F68 4699, EA50123C D1FB19A7, CE99CE5E 5028B41F, E39D190A 07D896DB, and B3BDD310 B2C50FA1.

If the preamble sequence is changed to a 0101 0101 . . . (formed by a cycle of 01) sequence, a sequence acquired by performing negation under binary on the sequence provided by the foregoing embodiment satisfies the characteristics of the burst synchronization delimiter of the present invention. For example, after the negation is performed on 111110000101001010011001, 000001111010110101100110 is acquired.

In the embodiment of the present invention, the device provides a delimiter sequence that is applicable to the GPON system of the next generation, and the sequence provided in the embodiment of the present invention may effectively improve the flexibility of the system.

Only exemplary embodiments of the present invention are described above, but the protection scope of the present invention is not limited thereto. Modifications and settings capable of being easily figured out by persons skilled in the art within the technical scope of the present invention shall be construed as falling within the protection scope of the present invention. The protection scope of the present invention shall be the protection scope defined by the claims.

What is claimed is:

1. A method of sending an upstream transfer frame in a Passive Optical Network (PON), comprising:

sending a preamble according to an allocated time slot; sending a burst synchronization delimiter, where in the sent synchronization delimiter, the number of non-zeros is the same as the number of zeros, and in a delimiter sequence, the number of non-zeros on odd bits is equal to the number of zeros on even bits, and the number of non-zeros on even bits is equal to the number of zeros on odd bits, wherein when the preamble is a sequence formed by a cycle of "10", the burst synchronization delimiter is hexadecimally represented as: A56679E0, and the burst synchronization delimiter is binarily represented as: 10100101011001100111100111100000; or the burst synchronization delimiter is hexadecimally represented as: BF05224F39, and the burst synchronization delimiter is binarily represented as: 1011111100000101001000100100111100111001; and

13

sending a burst header, a Gigabit-Capable Passive Optical Network (GPON) Transmission Convergence (GTC) frame header, and GTC frame data.

2. The method according to claim 1, wherein when the preamble is a sequence formed by a cycle of "01", the burst synchronization delimiter is a sequence acquired by performing negation under binary on the burst synchronization delimiter corresponding to the preamble that is the sequence formed by the cycle of "10".

3. The method according to claim 1, wherein before the sending the burst synchronization delimiter, the method further comprises: detecting a downstream broadcast frame sent by an Optical Line Terminal (OLT), and acquiring carried delimiter information from a Physical Layer Operation Administration Maintenance downstream (PLOAMd) instruction sent by the OLT.

4. The method according to claim 3, wherein a specific burst synchronization delimiter is selected according to the delimiter information carried in the PLOAMd instruction sent by the OLT.

5. The method according to claim 1, further comprising: before sending the burst synchronization delimiter, detecting an application function selecting instruction, and selecting a preset burst synchronization delimiter according to the application function selecting instruction.

6. The method according to claim 1, further comprising: determining, according to the burst synchronization delimiter, whether a corresponding function application is enabled by the OLT, wherein the preset burst synchronization delimiter has a corresponding relation with a function application instruction.

7. The method according to claim 1, further comprising: before sending the burst synchronization delimiter, detecting an application function selecting instruction, and selecting a preset burst delimiter according to a line encoding mechanism instruction.

8. A method of sending an upstream transfer frame in a Passive Optical Network (PON), comprising:
 sending a preamble according to an allocated time slot;
 sending a burst synchronization delimiter, where in the sent synchronization delimiter, the number of non-zeros is the same as the number of zeros, and in a delimiter sequence, the number of non-zeros on odd bits is equal to the number of zeros on even bits, and the number of non-zeros on even bits is equal to the number of zeros on odd bits; and

14

sending a burst header, a Gigabit-Capable Passive Optical Network (GPON) Transmission Convergence (GTC) frame header, and GTC frame data;

wherein if the preamble is formed by connecting a plurality of sequences being 10111011010100100001111000100110 from end to end, the burst synchronization delimiter is one of sequences, hexadecimally represented, in the following: 7C76510B, 0B787751, 7976510B, 4BDE1B90, A37670C9, B9D43E68462BC 197, BB509E6644AF61C9, FA321E2105CDE9D6, BB521E2244ADB1DD, B7521F0648ADE879, and ABD21E26552DE199.

9. A device of sending an upstream transfer frame in a Passive Optical Network (PON), comprising:

a preamble sending unit, configured to send a preamble according to an allocated time slot;

a synchronization delimiter sending unit, configured to send a burst synchronization delimiter, wherein in the sent synchronization delimiter, the number of non-zeros is the same as the number of zeros, and in a delimiter sequence, the number of non-zeros on odd bits is equal to the number of zeros on even bits, wherein when the preamble is a sequence formed by a cycle of 10, the burst synchronization delimiter sent by the synchronization delimiter sending unit is hexadecimally represented as: A56679E0, and the burst synchronization delimiter is binarily represented as: 10100101011001100111100111100000; or the burst synchronization delimiter is hexadecimally represented as: BF05224F39, and the burst synchronization delimiter is binarily represented as: 1011111100000101001000100100111100111001; and

a burst header sending unit, configured to send a burst header;

a Gigabit-Capable Passive Optical Network (GPON) Transmission Convergence (GTC) frame header sending unit, configured to send a GTC frame header; and
 a GTC frame data sending unit, configured to send GTC frame data.

10. The device according to claim 9, further comprising: an instruction detecting unit, configured to detect instruction information in a downstream broadcast frame sent by an Optical Line Terminal (OLT), wherein the synchronization delimiter sending unit selects a preset synchronization delimiter according to the instruction information and sends the preset synchronization delimiter.

* * * * *